

EMPLOYMENT EFFECTS OF AUTOMATION IN MANUFACTURING: EVIDENCE FROM REGIONAL LABOR MARKETS

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Working Paper Series, 2023

Abstract

This study investigates the employment effects of industrial automation across regional manufacturing sectors using establishment-level data from 2018 to 2023. Analyzing records from 3,200 manufacturing firms across 47 metropolitan regions, we estimate the impact of automation adoption on employment levels, wage distributions, and occupational composition. Our findings show that automation adoption is associated with a net reduction in routine manual employment of approximately 12 percent per establishment over a five-year period. However, this displacement effect is partially offset by employment growth in technical maintenance, programming, and supervisory roles. The net employment effect varies substantially by region, with labor markets featuring higher baseline skill levels and stronger retraining infrastructure experiencing smaller net job losses.

1. Introduction

The rapid diffusion of automation technologies in manufacturing has generated significant concern about the future of employment in the sector. Robotic process automation, computer-controlled machining, and artificial intelligence applications are transforming production processes across industries ranging from automotive assembly to food processing. While aggregate analyses suggest that automation may displace a substantial share of existing manufacturing employment, the actual effects depend on complex interactions between technology adoption patterns, workforce characteristics, and regional labor market conditions. This paper examines how automation adoption affects employment outcomes at the establishment level and how these effects aggregate to influence regional labor market dynamics. We focus specifically on the manufacturing sector, which has historically been at the forefront of automation adoption and which continues to employ a significant share of the workforce in many regions.

2. Methodology

Our empirical strategy employs a difference-in-differences framework comparing employment trajectories in establishments that adopted significant automation technologies with those that did not. The sample includes 3,200 manufacturing establishments across 47 metropolitan regions, drawn from administrative records maintained by regional economic development agencies. Automation adoption is measured using a composite indicator that captures capital expenditure on automation equipment, changes in the ratio of robotic systems to production workers, and establishment-reported integration of automated production processes. Employment outcomes are disaggregated by occupation type, distinguishing between routine manual tasks, non-routine manual tasks, routine cognitive tasks, and non-routine cognitive or analytical tasks. We control for establishment size, industry sub-sector, firm age, export orientation, and regional economic conditions.

3. Results and Findings

Establishments that adopted significant automation technologies experienced a mean reduction in total employment of 8.3 percent over the five-year study period, compared to a 1.7 percent decline in non-adopting establishments. The employment effects are concentrated among workers performing routine manual tasks, where adopting establishments experienced a 17.4 percent reduction in headcount. In contrast, employment in non-routine analytical and technical roles grew by 11.2 percent in adopting establishments. Regional variation in net employment effects is substantial. Metropolitan areas with higher baseline educational attainment experienced net employment declines approximately 40 percent smaller than the sample average. Regions with established workforce retraining programs also demonstrated more favorable outcomes, with displaced workers transitioning to new employment more rapidly. Wage analysis indicates that automation adoption is associated with increased wage polarization, with gains concentrated among workers in technical and supervisory positions while wages for remaining routine production workers stagnated.

4. Conclusion

The results confirm that manufacturing automation generates significant employment displacement, particularly among workers performing routine manual tasks. However, the magnitude and distribution of these effects depend critically on regional labor market conditions and the availability of workforce development infrastructure. Policy interventions aimed at facilitating workforce transitions through targeted retraining programs and educational investment appear to meaningfully moderate the adverse employment effects of automation. These findings underscore the importance of place-based labor market policies that account for regional variation in workforce composition and institutional capacity.